Title: **Natural Attenuation of VOCs at Wisconsin Landfills: A Preliminary Evaluation**

Project I.D.: DNR Project #153

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Background/Need: Unengineered landfills are a significant source of VOC contamination to groundwater. Unlike other sources of VOC contamination, such as underground storage tanks (UST) and spills, landfills are more difficult to remediate and represent a nearly infinite source of VOCs with potential to contaminate groundwater. Because of the expense associated with conventional remedies at landfills, natural attenuation as a remedy has come to the forefront.

Objectives: To evaluate the effects of natural attenuation processes on VOC contamination at landfills in Wisconsin.

Methods: We selected 31 landfills throughout Wisconsin based on these criteria: closed or closing; accepted primarily municipal solid waste; sampled for VOCs for at least 10 years; files contained the most complete site characteristics and VOC results. We divided the VOC data into three groups: the 49 total VOCs commonly sampled at landfills in Wisconsin, a subset of BTEX compounds and a subset of Chlorinated Ethanes/Ethenes. We constructed trends of VOC concentrations through time for total VOCs and the two subsets and applied a Mann-Kendall statistical test, using a 95% confidence level, to all the trends. To determine the processes that affect the concentrations of VOCs at each site, we reviewed inorganic parameter trends at each site. We also looked at total VOC trends for each individual well and compared those trends to the trends of the summation of all wells. This was done to determine the effect the summation of concentrations had on the overall BTEX, Chlorinated Ethanes/Ethenes, and total VOC trends. Included in this study is a sampling characterization of private wells that are within 1200 feet of a landfill. The majority of private wells were selected based on recommendations from DNR staff.

Results and *Discussion:* VOC concentrations changed over time in a predictable manner similar to what has been described in the literature at other VOC contamination sites. However, at landfills the concentrations took longer to stabilize and stabilized at higher levels than at other types of sites. At most VOC contaminated landfills, the chlorinated aliphatics made up the bulk of the total VOC concentrations in groundwater. Additionally, cis 1,2 DCE was consistently at the highest concentrations of all the chlorinated aliphatics. The highest concentrations of the BTEX compounds were present at the water table wells near the waste mass and the chlorinated aliphatics at

the deeper piezometers downgradient from the waste mass. Most of the sites in this study exhibited stable or decreasing trends for all three groups of VOCs.

Conclusions/ Implications/ Recommendations: Natural attenuation processes were occurring at most of the landfills in this study as evidenced by the large number of stable or decreasing concentration trends. Additionally, the natural attenuation processes working at other types of sites, such as UST and spill sites were also the primary attenuating processes acting at the landfills. However, VOC plumes at landfills usually consist of BTEX, chlorinated aliphatics, and other VOCs as a suite, and represent a much greater total contaminant source than do the other types of VOC contaminated sites. These and other differences make it difficult to characterize and predict the behavior of VOC plumes at landfills. If natural attenuation is to be considered a remedial alternative, these obstacles have to be overcome. One way to do this is to ensure that the monitoring well network captures the entire plume in all three dimensions, both now and in the future. From this study it was fairly apparent that the BTEX species were highest in the water table wells near the waste mass and the chlorinated aliphatics were greatest downgradient and deeper. However, a more detailed study focusing on the spatial aspects of VOC plumes zonation at landfills should be done to verify this finding as well as aid in future monitoring well network design.

Related Publications: None to date

Key Words: VOCs, Natural Attenuation, Landfills, Chlorinated Solvents, BTEX, Groundwater Contamination

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Final Report: A final report containing more detailed information on this project is available for loan at the Water Resources Institute Library, University of Wisconsin - Madison, 1975 Willow Drive, Madison, Wisconsin 53706 (608) 262-3069.